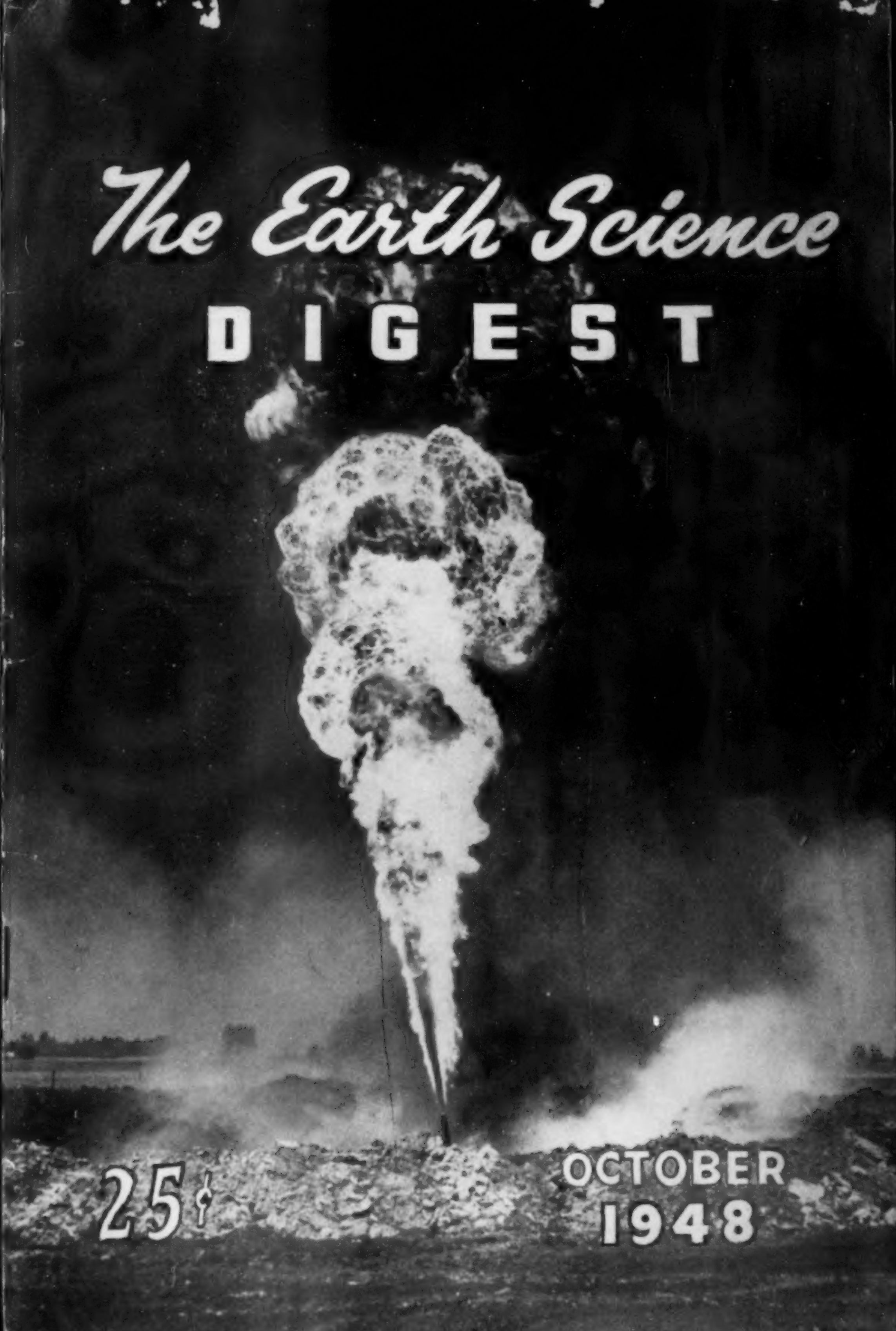
The Earth Science DIGEST



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OCTOBER 1948

The Earth Science Digest

Revere, Massachusetts

A magazine devoted to the advancement of the geological sciences.

Jerome M. Eisenberg, Editor

THE EARTH SCIENCE DIGEST is open to articles of geologic interest. Manuscripts, photographs and sketches will be returned if accompanied by ample first-class postage.

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S. Albert Eisenberg, Publisher
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Contents

EASTERN FEDERATION MEETING TO BE HELD IN NOVEMBER

The organizing meeting of the proposed eastern federation of mineralogical and geological societies will be held in New York City on November 10.

Questionnaires were sent to the different societies in August, and the following organizations have signified their interest in the federation:

Connecticut Valley Mineral Club, Springfield, Mass.

Georgia Mineral Society, Atlanta, Georgia.

Junior Mineral Exchange, Revere, Mass.

Mineralogical Society of Springfield, Vermont.

Mineralogical Society of the District of Columbia, Washington, D. C.

Newark Mineralogical Society, Paterson, N. J.

North Jersey Mineralogical Society, Paterson, N. J.

Oxford County Mineral & Gem Assoc., Bryant Pond, Maine.

Queens Mineral Society, Richmond Hill, New York.

Rock and Mineral Club of Bellows Falls, Vermont.

Stamford Museum Mineral Society, Stamford, Conn.

The meeting will be attended by representatives and members of the various organizations to officially form the regional federation, to draw up a constitution, and to make plans for a convention in the summer of 1949.

Those who wish to attend this meeting should contact the organizing chairman, Jerome M. Eisenberg (% The Earth Science Digest, Revere, Mass.), to obtain information on the exact place and time of the organizing meeting, which will be determined later this month.

COVER PHOTO

A new oil well is "blown in" in the Alberta, Canada, oil fields as mud, water, oil and gas shoot upward.

Read "Alberta Province May Be Canada's 'Oklahoma'" on page 24. A Science Service photo.

EXPLORING THE "MYSTERIOUS"

CHARLES E. HENDRIX
Boston University

Part Two of a Two-Part Article

So far we have said little about the many types of formations that beautify our caves. As mentioned before they are formed when water laden with dissolved calcium carbonate evaporates and leaves the solid behind. They consist principally of calcite or aragonite, both of which are forms of calcium carbonate, although traces of other metallic salts may give them brilliant colors. Sometimes there is enough mud carried in with water from the surface to give them a dirty brown appearance. The calcite or aragonite crystals vary in size from microscopic to very large.

When such a formation grows from the ceiling of a cave it is called a **stalactite.** Their general appearance is that of an icicle. When broken off, stalactites often display growth rings like trees; probably corresponding, as do those of trees, to wet and dry seasons. Usually there is a small hole through the center of a stalactite through which most of the water flows and drips off the end. The size of a stalactite is not so much a function of its age as the amount of water that comes through the ceiling at that point, and the amount of dissolved limestone carried in the water. Statements have been made as to the volume of stalactitic material that is deposited in a year, but they only give a rough order of magnitude. It is my guess that any amount up to several cubic inches might be deposited in a year's time, depending on the variables given above. The rate of deposition should also depend on the rate of evaporation in the cave. If the humidity is high, then little water will evaporate and the growth will be slower than if it were in a dryer atmosphere. Of course the humidity is nearly always near the dew point in a cave, but it must vary over small limits in different caves.

Stalactites are usually circular in cross section because the water source is concentrated at a point in the ceiling. If, however, a crack in the ceiling has an even distribution of water flow from it a flat "curtain" type may grow. These can be very thin; are sometimes transparent or translucent, and when struck may emit bell-like tones.

When the water that drips from the end of a stalactite strikes the floor, it has another chance to evaporate. Consequently under a stalactite there is often built up from the floor a **stalagmite.** In general, stalagmites are denser than stalactites; there is no hole in the center, and the end is more rounded than that of the stalactite. Often a stalactite and its stalagmite will grow so long that they meet and form a continuous column. Such columns may grow to enormous weight and size.

Because the water striking a stalagmite will splash, they are of larger diameter than the corresponding stalactite. Often, too, weird and complicated shapes result from this splash.

A special form of stalactite that sometimes develops is known as the "spaghetti stalactite". As the name implies, they are small in diameter with a large central hole, giving a very thin walled structure. They grow very straight and will get quite long if they are not disturbed. Since they grow almost entirely downward with little or no deposited material being used to broaden or thicken the walls, they increase in length very rapidly, sometimes several inches in a few months. They may be the result of a ceiling water source that occurs at a single fixed point rather than over a small area. Also, it may be that certain conditions of flow rate and solute content are conducive to their formation. It is possible that they are young stalactites and after a few years existance as a spaghetti tube they will begin to thicken and become the more usual type.

Another rather common type of stalactitic formation is known as "flowstone". It is usually described as looking like a "frozen waterfall". Whenever limestone laden water flows over a ledge or from a horizontal crack in a wall, flowstone is likely to be formed. It appears first as a thin coating on the wall below the ledge or crack and gradually thickens until it takes on the characteristic waterfall form. I have seen a thin, transparent layer of flowstone covering candlesmoked names and dates only a few years old. Perhaps some explorer of the future will chip the stone away, to discover the "fossilized" inscription!

A very rare type of formation is the helectite. Sometimes a stalactite will start its ilfe quite normally, and then suddenly begin growing sidewise instead of downward! Some have been observed to grow upward. Other times a stalactite will have branches growing from it at all angles, apparently defying the laws of gravity. There is no scientific answer to the riddle of the helectite. The answer may lie in peculiar crystal growth, or in surface tension effects in the water drops. A water faucet which is not opened fully will something exhibit a phenomenom where the stream seems to dribble from the side, often making a pronounced sidewise bend. It is hard to see how this theory could explain upward growth, however.

Some of the most beautiful of all cave deposits seem to be associated with small pools of water. Supposing calcium carbonate laden water collects in a small depression in a cave floor, and then has the opportunity to evaporate. As the pool grows smaller a rim of deposited limestone will be left behind. Now, if the cycle of filling and partial evaporation repeats itself many times the rim will be built up into an appreciable dyke, enclosing a crystal pool. These dykes seem seldom to be solid ridges; instead they are of a beautiful, lacy character which is almost never equalled. If these pools are left undisturbed for some time, a thin film of calcium carbonate will form on top of the water and due to surface tension, will float until it grows too thick and heavy to be supported. In a cave one of the most entrancing discoveries can be one of these tiny fairylands with its series of white lacy bordered crystal pools.

One of the rarest of all cave formations is the "cave pearl". M. Norbert Casteret in his book, **Ten Years Under the Earth,** which incidentally is probably the best existing treatise on caves, tells of having seen cave pearls only once in a long career of exploration. They occured in the pool at the foot of an underground waterfall and were spheres of calcium carbonate, perhaps deposited around

Stalactites, Luray Caverns, Va. — Photo by James

grains of sand. The continual stirring action in the waterfall kept them smoothly polished and spherical as they grew. The cave in which M. Casteret found them is in the Pyrenees Mountains on the Franco-Spanish border. Perhaps a similar find awaits some American explorer!

In addition to deposited forms in caves, many strange and beautiful shapes are found that are the result of erosion. In the original dissolution of the rock there are often strata or imbedded concretions that are less soluble. These hard layers and concretions are left behind providing many interesting forms.

Many caves are marred by great deposits of mud brought in from the surface where the water inlet is of sufficient size to permit the passage of solid matter. Sometimes a cave, or part of one becomes completely filled with it. A cave in St. Louis, Missouri was recently discovered to be much larger than it was previously thought, when great quantities of dried mud were excavated. Buried in the mud were the skeletons of a troop of wild hogs which had fallen into the cave (probably through a sinkhole entrance) and perished there. The mud was completely dry and the skeletons were very well preserved. They had undoubtedly been there many, many years.

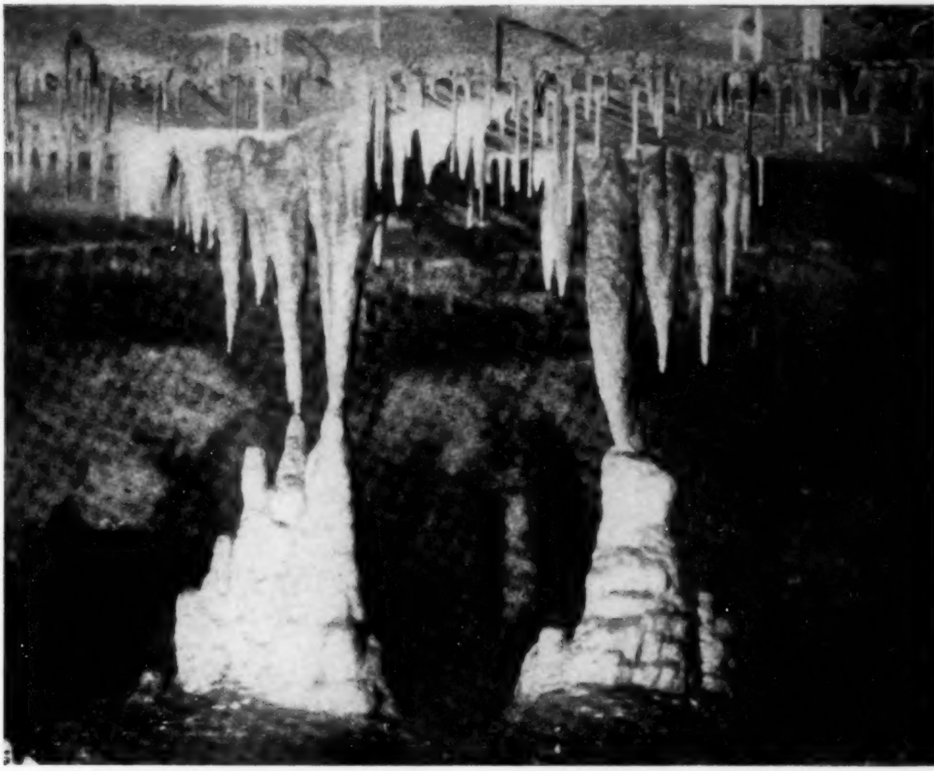
Cave mud seems to play a part in the formation of saltpetre or potassium nitrate that is found in many caves. It is thought to be the result of large deposits of bat guano which becomes buried in the mud and decomposes into the mineral form. In earlier days, the nitrate was mined from the caves and used in the manufacture of gunpowder.

For the person with an adventurous or scientific turn of mind, cave exploring can be a fascinating hobby. You can do as much in the line of scientific observation as you wish, or you can go solely for the sheer enjoyment of the underground beauty. You can survey and map the caves you expore, you can photograph them, collect geological specimens (more about this later), and observe plant and animal life. For the person with an eye for business, a cave in the proper location can make a wonderful tourist attraction.

Is it dangerous? Yes—everything is. With only reasonable precautions, however, you are as safe as when crossing the street or flying a plane or taking a bath. You will find many people who have a horror of caves and will recount the story of the death of Floyd Collins in shocked tones. Collins, however, did not die in a cave but a fissure in the rock which he had hoped would lead into a true cave beyond. Also, being an experienced explorer, he was alone. This, in my opinion, is one of the first things to avoid when exploring a cave. There are hazards as anywhere else and if you fall and break a leg it is good to have someone to go for help. Remember that most caves are "off the beaten path" and the chances of being found should harm befall you are small. Also having a companion to talk to is one of the best insurances against claustrophobia and panic. Once I crawled down into a narrow passage that descended rapidly. The floor was very slippery with mud and I had a great deal of trouble in climbing back up the well-lubricated slope. I made it by myself, but the knowledge that I had a friend who could go get a rope and pull me out was a great relief.

What precautions should be taken against getting lost? Well, the best insurance is self-assurance. If you are alert and observant you should not have too much difficulty in finding your way around. There are landmarks of every description, **no two of which are really alike.** Learn to look for distinguishing features, outstanding stalactites, peculiar formations of all kinds. Also if you remember that every cave, with the possible exception of the fissure cave, **is or was a watercourse,** you should have little trouble. Water must go somewhere and must come from somewhere, and the chances are that the entrance you used is either an inlet or an outlet depending on the type of cave. If you are not sure of yourself you can make frequent marks by scratching with a stone or with candle or carbide lamp smoke. The old standby of unrolling a string is always good in case a cave is extremely complicated and tortuous. By employing a little common sense and your knowledge of cave types you should have no need ever to become lost.

Now for the subject of equipment. As in any type of hiking, take as little as you can get along with. Don't weight yourself down with unnecessary articles. First, you need a good light of some kind, one for each member of your party. Flashlights are fine, if you carry extra batteries. Two or three hours of continuous service may exhaust the best of



Stalactites and stalagmites, Marengo Cave, Indiana.

batteries, particularly if they are not very fresh. Candles and miner's acetylene or "carbide" lamps shed an amazing amount of light. You can carry an old tobacco tin filled with enough calcium carbide to last for a day. The other ingredient necessary for operation of a miner's lamp is water and caves are nearly always too abundant in that regard! Besides you will usually want to carry a canteen of drinking water.

If you suspect or know that a cave has several different levels, thirty to fifty feet of light rope will come in handy. A 3/8 inch hemp rope will support the average person safely. Don't trust cotton rope; it deteriorates quickly if it has been wet. I am told that nylon rope now available is very light and strong. Many people like to wear a "hard hat" such as miners wear. They will protect your head against many a nasty bump. However they tend to fall over your eyes when you are in a crawling position. Don't wear too much clothing. The majority of caves remain at about 60 degree F. winter and summer and since you will be exercising rather strenuously, light clothing is sufficient. It should be durable, though, as every cave has literally thousands of places where you may tear your clothing. It should be something you don't mind soiling as it will surely get dirty quickly. A suit of one-piece coveralls is very good. If you get into a tight place and have to back out there is no jacket to roll up and wedge you in.

Unless you want to map a cave, a compass is not necessary. The ordinary means of finding your way will suffice very well. A cave is not an unmarked ocean. For mapping, you will need at least a compass and a tape measure. If you are going to determine elevations some sort of transit is necessary. I have known clever cave surveyors who built transits which were good enough for the purpose and which were much lighter in weight than the standard surveying instrument. Mapping will also tax your ingenuity as you have to portray three dimensions on your map.

Photographers can determine their own needs in taking underground pictures. Carry all your equipment in a case. Mud is nearly universal and can ruin an expensive camera. If you do not feel like carrying flashbulbs, I have found that flash powder is fairly satisfactory, if somewhat smoky. If you can't buy it, mix equal portions of magnesium powder and potassium chlorate. Place a pile of this mixture on a piece of paper in a convenient location. Open shutter, light with a match, wait for powder to flare up, close shutter. Admittedly, determining exposures is difficult.

A word about collecting geological specimens. It takes thousands of years for an average sized stalactite or stalagmite to grow. Many of our caves have been denuded of their beautifying formations by souvenir hunters who "must have one to take home". In order to preserve this great source of natural beauty, we should refrain from breaking off the delicate formations. I believe some state legislatures have ruled the defacing of caves to be illegal. Think of the people who will come after you and leave the caves as undamaged as possible. And remember, that deprived of its natural setting and life-giving waterflow a stalactite or stalagmite becomes a rather dull, ugly piece of stone. You will usually find fallen stalactites, anyway, which can be removed without really impairing the beauty of a cave.

So if you have the pioneer spirit and enjoy making discoveries for yourself, try cave exploring. Caves are found in nearly every state and there are thousands which are totally unexplored or only partially explored. Many caves which have been commercialized for years have unexplored and undiscovered passages. For the adventurer, the naturalist, the lover of natural beauty, the underground world is a new frontier!

The Earth Sciences — 1948

by Science Service

TINY CRYSTALS PUT IN THIN CASTS FOR STUDY

CAMBRIDGE, Mass., Aug. 21—Crystals which are invisible in any existing microscope are now being put in casts a millionth of an inch thick so that their structure can be seen.

The tiny crystals are so small that they can not be seen with an ordinary microscope, and they will not let streams of electrons through them for study with an electron microscope.

C. J. Calbick of the Bell Telephone Laboratories, Murray Hill, N. J., reported at the International Congress of Crystallography held at Harvard University here that models of the crystals which can be studied with an electron microscope have been made.

Each crystal is coated with a thin film of silica, the main ingredient of sand. Then the crystal is dissolved in acid, leaving the thin silica wall as a replica of its surface. This shell is transparent to electrons.

Two different views of the crystal shell, seen through the electron microscope, give a three-dimensional picture of the crystal. The same principle is used to give depth to pictures seen through a parlor stereoscope.

PROGRESS REPORTED IN OIL RECOVERY FROM CANADIAN BITUMINOUS SANDS

EDMONTON, Canada, Aug. 23—Bituminous sands of Alberta, a great untapped source of fuel oil and gasoline, are gradually yielding to research scientists trying to find an economical process for the extraction of their petroleum. The research is being undertaken both by the Canadian government and the Research Council of Alberta, located here at the provincial university.

The so-called Athabasca tar sands are in a 10,000-square-mile area north of here. Estimates vary on their petroleum content but it has been placed as high as 250,000,000,000 barrels. There is no question regarding the possibilities of extractting oil from them; the problem is to find a way at a low enough cost.

A government-sponsored separation plant is being erected at Bitumount on the Athabasca river. It contains a hot water separation unit designed on the results of researches of the Alberta Council. The recovery of oil by the hot water separation process is from 80% to 90% from good grades of sand. Waterflooding of the sands in place is a promising method of oil recovery.

Work has continued during the past year on applicability of water-flooding to the bituminous sands, an annual report of the council, just issued, states. Measurements of the viscosity of the bituminous sand oil and of the viscosity-temperature relationship show that the viscosity decreases very rapidly as the temperature rises above 32 degrees Fahrenhit to about 100 degrees. It decreases slowly above 150 degrees.

It can be said with considerable definiteness, the council asserts, that the viscosity of the bituminous sand oil at formation temperature is too great for water-flooding, and that a successful application of this method of oil recovery will involve the heating of the sand beds, in place, to temperatures above 100 degrees.

Water under practicable pressures will flow through bituminous sand at 36 degrees Fahrenheit, and will displace oil. The flow of oil is small, however. At 150 degrees, on the other hand, the flow is usefully great and half the oil is displaced before the ratio of water to oil in the flow becomes unduly high.

UPPER RIGHT LEG BONE IS NEW MAN-APE CLUE

BERKELEY, Calif., Aug. 25 — An upper right leg bone found in South Africa is the latest link in the evidence showing that the man-ape, a creature higher than the modern apes and lower than the most primitive man, walked erect on its hind feet.

The bone was brought back by Dr. Frank Peabody, of the University of California's African Expedition, who has just arrived here.

The man-ape, which was first discovered by Dr. Robert Broom of the Transvaal Museum in South Africa, had a larger brain capacity than modern apes and an almost human pelvis. There is a possibility, Dr. Peabody said, that the man-ape was contemporary with the early forms of man and that it may have lived as late as the early ice age. The ice age which was tens of thousands of years ago is still comparatively recent in terms of the age of life on the earth.

Although Dr. Broom reported that the man-ape could use its hands for the manipulation of tools and weapons, Dr. Peabody found no evidence that he used implements or fire.

Three tons of fossils were shipped to the University of California by the expedition. An analysis of the animal fossils may lead to the determination of the times when these animals lived. Fossil plants also will help in determining the periods when various plants and animals flourished in South Africa.

A large collection of fossils from Karroo, near the southern tip of Africa, where there are rich deposits of certain periods, contains mammal-like reptiles which bridge the gap between reptiles and mammals in evolution.

SCIENTISTS FEEL SURE WORLD IS NOT GOING TO TIP OVER

WASHINGTON, Sept. 2—Scientists are not worried about the world tipping over —physically and literally, at least.

A publicized theory suggests that the weight of the Antarctic ice cap may be enough to roll the world over. Such a drastic event would presumably flood most of the lands of the earth. To prevent this, it is proposed that atomic bombs be used to break up the ice at the South Pole.

But the scientists who study the development of the earth are not concerned. U. S. Geological Survey scientists doubt that any existing polar ice masses are capable of tipping over the globe. One argument against it, they explain, is this:

During the Ice Age, much greater quantities of ice were found at the North Pole than are now found on the earth. It is known that this ice did not tip over the world.

Even if there were such a threat, some scientists pointed out, atomic bombings would not make much of a dent in the ice.

MOST COMPLETE COLLECTION OF SKULLS AND BONES IS PLANNED

WASHINGTON, Aug. 25 — World's most complete collection of the skulls and bones which trace the development of man from his most primitive stages is now being built up at the Smithsonian Institution here.

Casts of bones scattered throughout the world will be made to give the Institution a complete collection of existing specimens. This will enable scholars to study the skulls and other bones without traveling to many different places or relying on the descriptions made by other scientists.

The casts will also give an accurate copy in event of loss of an original specimen. This has happened in the case of the skulls of China man, which disappeared from Peiping during the war and are believed to have been lost at sea. Casts of the skulls of China man were made before the war and are in the Smithsonian collection.

AUSTRALIA'S "ANCIENT MAN" TOOTH BELONGED TO ANCESTOR OF KANGAROO

LONDON, Sept. 5 — For nearly 80 years, Australians have treasured as evidence of the antiquity of man in their country a supposed human molar tooth.

Found in the Wellington caves of New South Wales, imbedded in rock with prehistoric animal remains, it has been considered belonging to a period of 7,000 to 12,000 years ago.

Now it turns out that it is not evidence of an early Australian man but the tooth of a giant Ice Age wallaby, a kind of kangaroo.

Dr. H. H. Finlayson of the South Australian Museum tells the sad story in a letter to the British journal, Nature. The tooth is the posterior half of the upper fourth premolar of the right side of a kind of animal whose remains are found in profusion over a wide area of eastern and southeastern Australia.

VOLCANO NOW ERUPTING IS ONLY ONE OF MANY IN PHILIPPINES

WASHINGTON, Sept. 9—The volcano which has sent thousands of persons fleeing from its violent eruption on a small island in the Philippines is only one of half-a-hundred such craters which make the islands an active volcanic area.

Although Mt. Hibok Hibok has not erupted since 1871, no volcano in that region can be considered extinct. Technically, scientists here point out, no volcano is termed extinct if there is any record of its eruption.

Modern scientists have seen volcanoes born and grow, but their eruption is still a mysterious, unpredictable event. Like the earthquakes which may accompany an eruption, volcanoes can not be predicted with any accuracy beyond their possibility in certain regions.

History offers little encouragement for the fleeing inhabitants of the island of Camiguin. The last previous eruption began April 30, 1871, and continued for three years.

SOUTH PACIFIC EARTHQUAKE WAS AS STRONG AS FAMOUS JAP SHOCK

WASHINGTON, Sept. 11—The earthquake which recently rocked the south Pacific in the Tonga Island region was as strong a shock as the tremor which claimed 100,000 lives in Japan a quarter of a century ago.

The quake was rated at about eight on the scale devised by Dr. Beno Gutenberg of the California Institute of Technology. The disastrous Jap quake in 1923 also was listed as an "eight."

Also known as the Friendly Islands, the Tonga group is a British protectorate south of Samoa and east of the Fiji Islands. Population of the Tonga Islands is slightly more than 40,000 persons.

Scientists at the U. S. Coast and Geodetic Survey here, using telegraphic reports collected by Science Service from American observatories located the shock's epicenter at 21 degrees south latitude and 174 degrees west longitude. Time of the quake was 11:09.2 a. m., EDT, Sept. 8.

CHAINS OF ISLANDS WERE ONCE STRUNG OUT ALONG PRESENT COASTS

NEW YORK, Sept. 11—Chains of islands were strung out along the present coasts of the United States, while the continent was about half the size it is now.

This is how America looked half a billion years ago, in the new theory proposed by a Columbia University professor.

Shallow seas and deep troughs bordered a central lowland. The volcanic island chains followed roughly the present borders of the continent. This picture of early Paleozoic North America is being presented to the International Geological Congress in London by Prof. Marshall Kay, Columbia geologist.

Sometime during the Paleozoic era, Prof. Kay believes, the present limits of the continent were formed.

Study of rocks from the Atlantic and Pacific coasts have revealed fossils from that era. But the rocks have undergone great changes due to mountain-making movements during the Paleozoic, he points out.

Along the Atlantic coast, the early island chain stretched from Newfoundland to Georgia. It then curved westward along the northern edge of the Gulf of Mexico, into today's northern Mexico and back out to the modern Antilles. It finally reached into what is now northern South America. The Pacific chain extended from the Aleutians down through the coastal provinces and states, perhaps as far as the western Andes of modern times.

QUIET GEYSERS SUDDENLY ERUPT AT YELLOWSTONE PARK

YELLOWSTONE PARK, Wyo., Sept. 22 — Twin geysers, which have been only quiet, leather-colored pools as long as records have been kept, have suddenly begun erupting to heights of 60 feet.

The geysers, called Maggie and Jiggs, have been listed as dormant. How high and how long they erupted were not known. But these facts are now being added to park records since the new eruption of geysers at West Thumb.

THE WATER WITCHES ARE STILL WITH US

WILLIAM W. SCHIDELER

On Friday, November 7, 1947, a geology class at Carrol College was just beginning to consider the subject of ground water. As was his custom, the instructor opened the class discussion by asking his students if anyone had a question concerning the general subject of ground water. The first and only question for that particular class session was: "What about water witches?" Here is a question that has intrigued the curiosity and imagination of mankind since ancient antiquity. In answer to the student's question the instructor replied approximately as follows: "It would indeed be unscientific for anyone to make the flat statement that the long-mysterious art of dowsing, divining or water witchery by means of forked sticks is pure superstition and charlatanism. However, as far as I know, there is no scientific principle or objective evidence to substantiate the claims of the so-called dowsers, witches, diviners, or what, who insist that they can find underground water by employing a forked stick." At this point the instructor asked the student what he tought of witching for water. To the great astonishment of the instructor and the class, this student calmly replied that he himself was a water witch, that he had in fact located a number of successful wells in the Milwaukee area and had never had a failure. This young man proceeded to explain that all he needed was a forked willow stick and he could locate without fail the very best place to drill for water in any given area. No, anyone could provide him with a stick—he didn't have to select it himself—just as long as the stick was willow and forked.

Here was an opportunity too good to miss. It was decided to conduct a series of experiments directed toward proving or disproving the claims of a self-confessed water witch.

The more significant results of these experiments are listed as follows: (in all cases the witch was blindfolded and presumably did not know where he was.)

1. The witch was unable to locate a twelve-inch water main, full of water under pressure, extending across a large open field and buried four feet beneath the surface.

2. The witch was led over a bridge crossing the Fox River. At this point, the stick should have literally jumped out of his hands, but nothing happened—no indication of water from the witch as he was crossing the bridge. (He didn't know he was on a bridge).

3. He walked right up to a well of the Waukesha Water Works and indicated water at that point. However, in this case, the noise of the motor driving the pump could be plainly heard and a shrewd guess could have told him where he was.

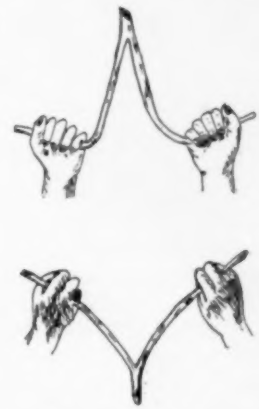
4. The witch was unable to locate a good-sized spring in one of the City Parks of Waukesha.

5. The witch located a number of points where he claimed "All the water you want" could be obtained by drilling a well; however, there was no way of checking on this.

When questioned as to the reasons for his failures described above, the witch complained that his stick was too dry, that there wasn't enough sap in it and that it was not limber enough—of course he had been perfectly satisfied with his stick at the beginning of the experiments. When queried as to the cause, source and nature of his alleged power, all the witch would say was "I simply can't explain it—I don't know—My Grandfather had the same power." It is the considered opinion of the writer that the student was absolutely sincere in everything he did and said.

The aforementioned experience motivated the writer to engage in a bit of research on the subject of Water Witches. Some of the more important findings of this research and the conclusions derived therefrom are presented in the following pages. But first a few words about what a water witch is, how he (I have never heard of a female water witch) operates, and his general background.

A water witch is a sort of magician who uses a forked stick instead of a wand. The water witch, sincerely or otherwise, claims an infallible ability to locate underground water by means of a broader claim than the geologist with his background of technical training would make. After selecting a forked stick that suits him, the witch holds the two branches of the fork in his two hands in such a manner that the butt end points up and out. The witch then walks slowly about, the superstition being that when the witch reaches a point directly above water, the butt end of the stick will be attracted downward, more or less violently. There are a number of minor variations in this procedure. Thus, each individual water witch has his own ideas as to how the stick should be held, the material of which the stick must be composed, (metal tubing and plastic materials as well as different kinds



The two usual ways of holding the divining rod. (After Ellis, 1917.)

of wood are used) and the way in which he should walk. Also, there is no set pattern for the movement of the forked stick in the hands of the witch, except in all cases the butt end of the stick points down when the witch reaches a point that is supposed to be directly over water. Some witches seem to go into a kind of cataleptic trance, exhibit muscular spasms and other symptoms of hysteria.

The origin of the "Divine Rod" or divining rod is lost in antiquity. Many more or less vague references to divining rods are found in ancient literature. The Bible makes frequent reference to the "rod" in connection with miraculous events, particularly in the books of Moses. The much-quoted passage: "And Moses lifted his hand, and with his ROD he smote the rock twice; and the water came out abundantly . . . " (Numbers XX, 11) has been held by the water witches to be divine sanction of their belief. In antiquity forked sticks and divining rods were used for the detection of criminals, to forecast the future, to locate veins of ore, and for other purposes intimately associated with alchemy and magic. It appears that the forked stick was first used to find water in Spain, in the middle part of the Sixteenth Century. From Spain the idea of "witching for water" gradually spread until when it is probably found in all parts of the "civilized world."

The widespread and long-held belief in water witches could hardly have developed unless the witches' successes had outnumbered their failures. However, in this regard it must be pointed out that taking the world as a whole, the successful wells far outnumber the unsuccessful wells—whether witched or not.

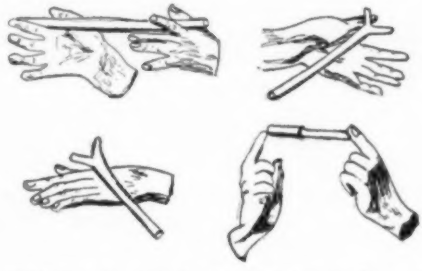
In 1946 a widely known agricultural journal polled some of the most eminent geologists in the country on the subject of water witching. Three significant conclusions were obtained from the results of this survey.

1. On the basis of their own personal observation and experimentation, none of the geologists stated that the water witch was effective in locating wells.

2. Most of the geologists answered in the same vein as C. S. Gwynn of Iowa State College who said: "Although I place absolutely no stock in water witching, I rarely try to dissuade others from their belief.

3. Most of the geologists who flatly denounced water witching as a fraud and superstition requested: "Please don't quote me."

Thus geologists as a whole look upon the water witch as a hoax and a fake, and yet these very same geologists are strangely reluctant to speak up with the courage of their convictions. The reason for this reluctance on the part of geologists to damn the water witches, despite their own feelings on the subject, is that they, as scientists, are unable to provide conclusive proof that forked sticks



Different types of old divining rods and the manner in which they were held. (After Vallemont, 1693.)

cannot locate water. However, the writer is of the firm opinion that the above described experiments are at least a "straw in the wind".

At least one eminent geologist supports the other side of the argument. Brigadier-General R. F. Sorsby, British author of the textbook "Geology for Engineers" (G. Bell, Toronto, 1938, $3.75), states on page 145 of his book ". . . when prospecting for water, the engineer will do well to call in the aid of a well-known water diviner. . . . There can be no doubt, in spite of the prejudice against this fact, that from medieval times up to the present time, water divining or dousing has been successfully used to find water."

The statements of professional well drillers on the subject of water witching run all the way from violent disbelief to complete faith. The concensus of opinion of well drillers appears to be that the chances of finding water at spots which have been witched are about 50–50 for any quantity of water.

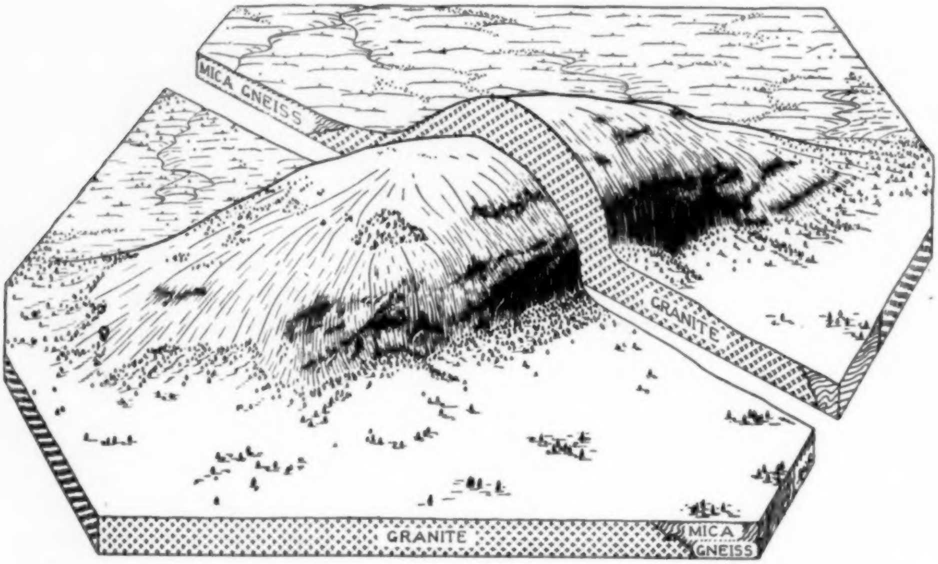
Enormous quantities of literature have been written pro and con water witching. Water-Supply Paper 416 of the U. S. G. S., "A History of Water Witching" by Arthur J. Ellis, contains a bibliography of well over five hundred publications dealing with the subject. Since Water-Supply Paper 416 was published in 1917, much additional material has been published as can be seen by referring to the "Readers Guide of Periodical Literature". The conclusions to be derived from Paper 416 are well stated by O. E. Menzer who wrote the introduction to the Paper. Menzer says on page 5 "It is difficult to see how for practical purposes the entire matter (of water witching) could be more thoroughly discredited, and it should be obvious to everyone that further tests by the United States Geological Survey of this so-called "witching" for water . . . would be a misuse of public funds." Menzer further states on Page 6: "To all inquirers the United States Geological Survey gives the advice not to expend any money for the services of any water witch."

Many things, including water witching, are not beyond the realm of possibility. However, until such time as conclusive objective evidence is presented that a forked stick or any other kind of divining rod will locate water, the writer will be of the opinion that "it just ain't so", that as its name implies, it is simply a form of witcraft.

(Reprinted from The Trilobite, official publication of the Wisconsin Geological Society.)

STONE MOUNTAIN, GEORGIA

GEOFFREY W. CRICKMAY



Block diagram of Stone Mountain as viewed from the east, showing geologic structure on sides and on cross section.

Stone Mountain, situated 16 miles east of Atlanta in DeKalb County, is an elongate dome of granite 1686 feet above sea level and 650 feet high. The mountain is only a small part of a much larger mass of granite which occupies an oval area five miles long and two miles wide. This great body of granite, by no means the largest in Georgia, was intruded as a molten magma into enclosing rocks to form a small batholith. The shape of this batholith is not known, but if similar to small intrusive bodies of the same rock encountered in other parts of the State, it is lens-like. The block diagram by Dr. G. W. Crickmay illustrates its structure and surface expression. The granite is believed to be around two hundred million years old, but the mountain is much younger.

This article is reprinted from The Georgia Mineral Society News Letter, edited by Dr. A. S. Furcron.

Introduction

Of all the scenic features of Georgia, Stone Mountain, situated 16 miles east of Atlanta, is not only the best known but is by far the most distinctive. In form, the mountain is an elongate dome of nearly bare granite more than 650 feet high, approximately one and a half miles long, and three quarters of a mile wide, with the longer axis in a northwesterly direction. The south side of the dome is a moderately steep slope, but the north side is a precipitous and imposing cliff. The accompanying block diagram is a birds-eye view of the mountain as seen from the east. In order to show the geologic structure, the block has been cut in half and pulled apart.

Stone Mountain is climbed by a trail that follows the long axis of the dome from a point on the highway near the northwest end, one mile east of the town of Stone Mountain. The crest, which is marked by an airplane beacon and a U. S. Coast and Geodetic Survey monument, has an altitude of 1686 feet. From this vantage point, the country surrounding the mountain appears to be a relatively flat plain stretching out on all sides as far as the eye can see. The plain is actually a rolling upland, the Atlanta Plateau, whose altitude ranges from 1000 to 1100 feet. The plateau is underlain by banded rocks, most of them very micaceous, which are far different from the massive granite of the mountain. The banded rocks, or gneisses as they are called, are much less resistant to erosion than granite, and it is for this reason that they have been worn down by meandering streams in ages past, leaving the more durable granite as a prominence.

Effects of Weathering

The granite, however, is not by any means immune to the destructive action of the weather. Irregularities, ranging from broad saucer-shaped depressions to pits resembling the pot-holes of stream channels, dimple the surface of the mountain, particularly the upper slopes. Rain water that collects in these depressions causes a partial decomposition of minerals which so weakens the rock that it readily crumbles to a sand. The rotting of stone by water appears to be due to an increase of volume through hydration which causes a disruption of the mineral grains. The loosened grains are washed away by heavy rains, or perhaps to a small extent are blown away by winds. The radially striped pattern of the mountain's surface is due to rainwash which carries down iron oxides and organic matter to stain the slopes. Rainwash, however, has practically no erosive power, as is shown by the fact that rill-ways are crossed by thin delicate walls of granite and have irregularly pitted surfaces quite unlike the smooth surfaces produced by stream erosion. The channels, like the weather pits, are almost entirely the result of disintegration due to hydration.

Exfoliation is another superficial feature that appears to be due to weathering, although the exact manner in which it develops is somewhat obscure. The entire surface of the mountain is made up of granite layers, called exfoliation shells, concentrically arranged to conform to the surface of th dome. In places the shells have been partially peeled off by the natural quarrying of tree roots and other agencies but, contrary to popular belief, the configuration of the dome is not determined by exfoliation, as demonstrated by two facts. There is practically no debris at the base of the mountain where such blocks would be expected to fall and collect as talus. The slabs that appear to be perilously near falling down the mountain side are etched by weather pits, showing that they have been there a long time and in all probability will remain in their precarious positions for a long time to come.

Volume and Mode of Intrusion

Stone Mountain, whose volume is roughly 20 billion cubic feet and whose weight exceeds a billion and a half tons, is only a small part of a much larger mass of granite which occupies an oval area measuring five miles in length and two miles in width. This great body of granite was intruded as a molten rock into the surrounding gneisses as a batholith, a name applied to all large masses of intrusive rock. The term batholith means simply "depth-rock," corresponding to bathosphere or "depth-sphere," and implies that the rock crystallized at great depth, perhaps half a mile or more below the ground surface. The Stone Mountain batholith is relatively small compared to some other batholiths of the state.

When the molten rock, or magma as it is called, was forced up from deep within th earth, the gneisses of the Atlanta Plateau must have covered the present site of the mountain, for otherwise the magma would have chilled and cooled so quickly that it would have become glassy instead of coarsely crystalline. It would, in other words, have looked more like lava than granite. But the roof of the batholith was not very strong, for blocks were worked loose and sank into the invading magma. A few of these blocks, frozen in the granite as it were, are to be found on the mountain side to prove the nature of the overlying rocks that have been entirely removed by erosion.

Crystallization of the Magma; Formation of Pegmatites

As the magma slowly cooled, crystals started to form, much like the sugar crystals that form in honey, until finally all the upper part of the batholith became solid granite, except for the so-called "granite juices" which remained liquid only by virtue of their high content of water and dissolved gases. These "juices" possessed a remarkable power of penetration, for they found their way into all the cracks and joints that developed in the cooling granite and even wedged their way between the individual mineral grains of the rock. Minerals crystallizing from the "juices" as veins formed a new rock known as pegmatite, which differs from the granite mainly in being very much coarser grained. The pegmatites of Stone Mountain are characterized by the mineral tourmaline, which contains the gas boron as an essential part of its composition. Veins of pegmatite are well displayed in an old quarry where the trail starts its ascent of the mountain.

Uses of Granite

The Stone Mountain granite is a coarse-grained, grey rock composed mainly of four minerals, feldspar, quartz, biotite or black mica, and muscovite or white mica, named in the order of decreasing abundance. The remarkably uniform character of the granite and the complete absence of iron sulphides are qualities that make Stone Mountain a structural stone unexcelled anywhere. The stone has been quarried intermittantly since 1845, but the early operations were confined to easily accessible ledges of partly decomposed granite. The use of this inferior stone led to an unwarranted condemnation of all southern granites by many builders. This early prejudice has now been entirely removed by modern quarrying methods, in which all unsound surface stone is discarded and granite production has come to be one of the state's leading mineral industries. The most extensive quarries are located on the south side of the dome. In recent years most of the granite quarried has been crushed and used for aggregate in road construction.

Minerals of the Granite

The mineral collector will find many specimens at Stone Mountain to enrich his cabinet. Besides the relatively common feldspar, quartz and mica, the following more uncommon minerals are to be found:

Tourmaline is a black aluminum

silicate containing boron and hydrogen. The mineral occurs in pegmatite veins and as radiating groups of crystals in the granite. These tourmaline "knots" are characteristic of Stone Mountain granite, and as the mineral is quite stable their presence is in no way detrimental. Some of the tourmaline crystals attain considerable size—one specimen was found with a length of more than a foot and a half. Very rarely the tourmaline is found in very fine-grained narrow veinlets.

Garnet is a pink iron aluminum silicate. It occurs in small but distinct crystals in some of the pegmatites and in a dense form in narrow veinlets. The mineral is most abundant in the quarries on the south side of the mountain.

Uranophane is a calcium uranium silicate of canary yellow color. It occurs as a coating on the surfaces of major joints associated with a glassy variety of opal known as hyalite. This mineral fluoresces a brilliant green under dark light. The radium content of the granite, which has been found to be greater than that of any other granite in the eastern United States, is thought to be related to the abundance of uranophane. Spring water from near the base of the mountain is also found to be unusually radioactive.

Other minerals collected in the Stone Mountain granite are zoisite, thulite, and stilbite.

A History Of Fossil Collecting

RICHARD L. CASANOVA

Part 3
The Age of Enlightenment

The 18th century, termed the "Age of Enlightenment", was to see tremendous progress being made in evolving a stratigraphical succession among the fossiliferous formations of Europe.

The battle of ecclesiastical authority versus the freethinkers continued in some countries, though diminishing rapidly as scientists were shown royal favor and court privileges. While volume after volume was printed wherein many excellent plates of fossils were to be found, the text still described fossils as "figured stones"; mere sports of nature—a thought that was to disappear in the freshness of a new century. For this certainly was to be a century which took the science of paleontology out of the darkness of dogma and mythology, and turned it into one of the most popular hobbies of the age. Collecting minerals and fossils and the formation of cabinets, or private museums became the fad of the day.

One such enthusiast was J. J. Scheuchzer (1672–1733), who in the year 1702, decided to publish a book on his collecting and cabinet. He titled it "Specimen Lithographiae Helveticas curiosae". Soon afterwards, Scheuchzer chanced upon a copy of Woodward's Essay, in which he saw the error in his previous thinking that such fossils as he possessed in his cabinet and wrote about were not relics of the deluge. Soon after reading Woodward, Scheuchzer

Johann Jakob Scheuchzer (1672-1733)

published another volume, entitled "Naturhistorie des Schweitzerlandes", in which he devoted a section to the description of a number of fossil plants and shells. Well taken as these two books were by the learned men of the day, Scheuchzer was to become famous for his dissertation "Homo Diluvii Testis". Written in 1726, he describes a large salamander-like animal which he thought to have been human. Writing of this skeleton, he describes it as being "one of the infamous men who brought about the calamity of the flood". Scheuchzer still had not completely turned away from the deluge theory insofar as human fossils were concerned. The storm of protest aroused by the "Homo Diluvii" brought forth from every center of learning in Europe a vast number of writings for and against the book. The Church applauded it, while cold, theorizing scientists criticized it in disbelief. The storm mattered little to Scheuchzer, for he was to round out his later years with the publication of two equally important works. The first was a catalog of fossils in which he listed all the then "classified figured stones", and also gave a brief bibliography of original descriptions. The second work referred to his celebrated "Herbarium Diluvianum", a volume which contained fourteen excellent plates of fossil plants and corals.

The science of fossil collecting was at last coming into its own. In Nuremberg, during the early years of 1705 to 1761, we find one of the greatest engravers of all Germany, busily engaged in preparing a treatise in many folio volumes on all the known fossils. The engraver was George Wolfgang Knorr, and his skill and exact eye for minute detail in his engravings was to present to the scientist of his day, as it does to the proud owner of his works today, a rare masterpiece. For sheer beauty and fidelity of presentation, his illustrations of fossils were unsurpassed.

Unfortunately, Knoor died soon after completing the first volume, and another fossil-collecting enthusiast, J. E. Walch, (1725–1778), a professor of Eloquence and Poetry at the University of Jena, took over the task of completing the work of Knorr. Walch was one of those rare individuals who could find poetry and beauty in ordinary rocks, which no doubt played a strong part in completing a work of four folio volumes of text and

One of Scheuchzer's plates of fossil plants and animals

nearly 200 plates of illustrations of fossils. The work completed was printed under the title of "Lapides Diluvii Universalis Testes—Sammlung von Merck wurdigkeiten der Natur zum Beweis einer allgemeinen Sundfluth". A tremendous title, and a tremendous work, which, with a volume containing systematic tables and an index, issued in 1778, presented an instructive and detailed account of all that was geologically known at that time. The printing of this work was to mark a notable advance in paleontology as a science in its own right. The first quarter of the 18th century was to pass with the craze for the collecting of fossils gathering momentum to such an extent that fossils were collected and written about with abandon and innocent credulity as to their true significance.

One of the most infamous jokes of the day was played upon a Wurtzburg professor named J. B. Burger, who was a very enthusiastic student and collector of Triassic fossils from the strata in his neighborhood. Burger made a large collection of fossils, and in 1726 published an illustrated work based upon the local fossils in his collection.

Among the objects collected and illustrated by him in this work, were stones depicting figures of celestial bodies, Hebrew letters and other things which he unsuspectingly found in the quarries. However, the truth that he had been hoaxed by his students finally dawned on him when he found one day his name inscribed on a stone. From that day on he feverishly attempted to buy up all the copies of his book still unsold, in which so many of the "planted" fossils had been illustrated and described. A few copies of this rare work survived and are to be found today in various European libraries.

The remainder of the 18th century was to see a host of world famous personalities studying fossils, preparing notable memoirs and maps and building the famous museums of natural history that house some of the greatest collections of fossils, not only throughout Europe, but in America as well. Taking first into consideration some of the best remembered paleontologists and amateur collectors of Europe, we find Ernst Friedrich von Schlotheim (1764–1832), the first German paleontologist to recognize the stratigraphic signficance of the occurrence of fossils. In 1813, he had printed his "Taschenbuch fur die Gessamte Mineralogie", in which he described the use of fossils in geological determination of outcrops.

William Nicol (1768–1851) was the first to describe the use of microscopic thin-sections of fossil plants in his 1831 issue of "Observations on Fossil Vegetables".

Cuvier "Georges (1769–1832), Father of French science, in his celebrated "Essay on the Theory of the Earth", published in 1817, included a memorable chapter on "Relations of the Species of Fossil Bones, with the Strata in which They are Found".

Alexander Brongniart (1770–1847), famed French mineralogist and zoologist, along with Cuvier, established new studies and methods in stratigraphic geology. His "Essai sur la geographie mineralogique des environs de Paris" issued in 1811, is an important a work of reference to the study of the Paris basin today, as it was on the day of publication.

Not only did the Canal diggings of Italy unfold a story of past earth history to Leonardo da Vinci, but a similar revelation was to make William Smith (1769–1839) the Father of English Geology.

Smith, who became a surveyor and civil engineer through his own initiative and hard study, was as a young man a great advocate for Canal navigation, and it was while he mapped and plotted out the course for the newly planned Somerset Coal Canal that he first noticed the strata which lay one on top of another like, as he said, "so many superposed slices of bread and butter". Smith surveyed and engineered the cutting of the Canal for six years; years which he gainfully spent in examining and collecting the fossils he came across in the diggings. But picking up the fossils just from the Canal banks and cuttings was not enough; Smith walked uncounted miles over the hills and valleys of Somerset and Devon in search of fossils. He began to trace known fossils within certain beds he plotted on his maps, then to trace the beds themselves from one locality to another, seeing both the variations and similarities of the beds.

Once having secured his facts, he decided that the fossils themselves showed the beds within a given time sequence, though miles apart, to be exactly the same in age and petrographic structure. For three more years, "Strata" Smith, as he came to be called, collected and studied his fossils, announcing finally to his many friends who shared the same collecting tastes, that "the same strata were found always in the same order and contained the same peculiar fossils".

In 1796, Smith began work on a book which he hoped would outline his observations of his "strata succession" principles. While reluctant to rush his facts and theories into print, he acted with haste due to the fact that many other continental paleontologists were approaching Smith's conclusions by their own personal studies.

About 1801 Smith had issued a prospectus of his intended work and a "Table of Strata". However, it was not until 1815 that the momentous volume under the heavy title of "A Delineation of the Strata of England and Wales, with part of Scotland, exhibiting the Collieries and Mines, the Marshes and Fen Lands originally overflowed by the Sea, and the varieties of Soil, according to the Variations in the Substrata, illustrated by the most descriptive names". Due to ill fortune, Smith

William Smith (1769-1839), the Father of English Geology

at this time was forced to sell his huge collection of fossils, as well as his entire personal possessions, and for some years lived from inn to inn or from one friend to another. These years were completely given to the writing and illustrating of his "Strata Identified by Organized Fossils", published in 1816, the plates being printed in a paper whose color matched that of the rocks so skillfully engraved and listed.

The "Stratigraphical System of Organized Fossils", a work based upon the collection of fossils he had sold to the British Museum some years before, was published in 1817. From that year till his death in 1839, Smith was busy publishing other "geological sections and views", giving lectures, and spending what remaining years were left to him in touring England and Wales.

ALBERTA PROVINCE MAY BE CANADA'S 'OKLAHOMA'

Athabaska Tar Sand Deposits May Be New Source for U. S. Oil Imports

Athabaska tar sands of Alberta Province, West Canada, together with oil wells in other locations, may make that province the "Oklahoma" of our northern neighbor. The greater market for exported products would be naturally the United States.

The tar sand deposits, also known as bituminous sands, are found in a great area north of Edmonton near the Athabasca River. Some estimates state they may contain as much as 250,000,000,000 barrels of crude oil. That they hold great quantities of oil is unquestioned; how to get it out economically is the troublesome problem still unsolved.

The United States also has tar sand deposits in Utah, California, Alabama, Kentucky and Oklahoma, but they are very much smaller, being represented to have a potential gasoline reserve of less than 3,000,000 barrels. Tar sands are more or less common sands which are stuck together with a black tarry material with a strong asphalt-like smell.

The oil can be removed by washing the sand with hot water, or it can be distilled directly from the sand by a process somewhat like the recovery of oil by distillation from American oil shale. The washing process may recover up to 90% of the oil, but before this crude can be refined into the various petroleum products some economical method must be found to separate out of it quantities of water and minerals that are found in it.

Alberta's new oil field, one that holds out great promise, is some 20 miles south of Edmonton. Less than two years old, 100 wells have already been drilled and 300 more are now planned. These wells, in the Leduc area, are only 5,000 feet deep. Alberta's Turner Valley wells are twice as deep. The oil quality in the new field is reported high; it can be used in farm tractors as it comes from the ground.

Edmonton lies on the east slopes of the Rocky Mountains. Transportation to the West Coast would encounter great difficulties. However, a 1000-mile pipe-line to Duluth would deliver oil to tankers on the Great Lakes. An even shorter pipeline would take the crude to the west coast of Hudson Bay for tanker shipment to any foreign ports.

New Books

PHYSICAL GEOLOGY

By Chester R. Longwell, Adolph Knopf, and Richard F. Flint.

John Wiley and Sons, Inc., New York, 1948. 3rd Edition. 602 pp. — $5.00

The past record of **Physical Geology** speaks for itself. For 16 years it has been the standard textbooks of physical geology in American colleges. More than 135 colleges and universities in the United States and Canada were using the second edition at the time the third edition was issued. Obviously it has been considered the best book in the field.

The authors believe that understanding the basic concepts of physical geology is more important than memorizing a large number of details. In keeping with this idea, they have removed much of the purely factual material—such as lists of the properties and characteristics of minerals—from the body of the text and placed it in the appendixes. This arrangement serves two purposes:

(1) the explanation of principles is not interupted by pages of factual details.

(2) since the properties and characteristics of each mineral, along with basic definitions, are grouped together, the appendix forms a fine reference manual which can be consulted as needed.

In some ways, what we don't know about geology is even more interesting than what we do know. The authors point out these blank spots in our knowledge and discuss some of the possible explanations. This leaves room for controlled speculation and adds to the interest of the book.

The three authors make an unusually good team of writers for a book on geology. Their teaching and field experience has been in different branches of the subject: Professor Longwell in general and structural geology, Professor Knopf in petrology, and Professor Flint in geomorphology.

Most of the illustrations from the second edition have been revised or replaced by new ones. The total number has been increased from 341 to 365.

MINERALOGICAL AND STRUCTURAL EVOLUTION OF THE METAMORPHIC ROCKS

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OPTICAL PROPERTIES IN CLEAVAGE FLAKES OF ROCK-FORMING MINERALS

By E. D. Taylor

University Laval, Quebec, 1948
80 pp. — $3.50

This work by Mr. Taylor represents a very pertinent contribution to determinative optical methods. Close to 170 common rock-forming mineral species or varieties are listed with the optical properties which can be observed under the microscope when the mineral is lying upon a cleavage face. If the mineral has more than one cleavage, the optical properties for each are listed separately. Nine tables are offered, listing the optical properties on the cleavages, the various tables representing the various possible relative orientations of cleaveage and the optical indicatrix.

One of the outstanding features of the work (which represents an unusually high calibre of work for a Master's thesis) is the depiction of the optical orientation relative to cleavage on 98 small but clear stereographic projections. Beginning students are often puzzled by their inability to obtain good optic figures, and these projections will serve a useful explanatory purpose in such cases. The practical value of the projections in demonstrating just what can be seen down the tube of the microscope is considerable. Still another useful tool made available is the relation between apparent optic angle and true optic angle; this is done both in a large graph and in a tabulation.

Mr. Taylor emphasizes the determinative value of birefringence in optical work, pointing out that both thickness and birefringence of a grain can be readily measured or calculated from observed data. Since the birefringence of a given thickness of a mineral in a particular orientation is a constant for that species, and since mineral grains tend to lie on preferred orientations, the cleavages, the value of a tabulation of birefringence of the different minerals in their preferred positions under the microscope is readily apparent.

One of the problems faced in the work was the description of cleavage. The distinction between ease of cleavage and quality of cleavage is not generally made by most mineralogists; such a distinction does not appear, for example in Dana's System of Mineralogy, which is compelling evidence that the distinction is not often made. Taylor suggests that such a distinction should be made, and the small evidence at hand indicates the correctness of his view.

The tables and figures will serve as very useful tools in optical investigations of the common rock forming minerals. Of course, their use will require a certain amount of study and practise, but both should be well worth the effort.

C. W. Wolfe.
Boston University

PHYSICAL GEOLOGY SLIDES ISSUED BY WILEY

In conjunction with the publication this month of PHYSICAL GEOLOGY, third edition, well-known geology textbook written by Chester R. Longwell, Adolph Knopf and Richard F. Flint, John Wiley & Sons have issued a new set of 250 custom-made color slides to assist the many college and university geology instructors using the book in teaching their courses. At a preview showing of a large number of the slides in this series held at the Hotel Commodore in New York on Monday, September 27, Dr. Ned L. Reglein, director of the Wiley visual aids department, stated that "the development of this set of visual aids, believed to be as comprehensive a collection as has ever been made available generally, marks an important forward step in the improvement of geology teaching."

Outlining the history of the preparation of this series of color slides, Dr. Reglein reported that it was decided to start from the beginning and obtain views which exactly depict what is described in the book rather than rely upon already existing materials. Consequently, Professors Longwell, Knopf and Flint, all of whom are members of the Yale University faculty, set up individual specifications for each picture to be included in the set. Dr. Orlo Childs of the University of Wyoming, a geologist who is also an experienced cameraman, was engaged to make the necessary field trip and to take the required pictures. Four months later, with a 21,000-mile trip behind him, Dr. Childs returned with about 800 color photographs. Out of these, the authors of PHYSICAL GEOLOGY and Dr. Reglein selected the 250 best examples illustrating the principles set forth in the book.

The slides are arranged to follow the general chapter pattern of the book for which they were designed. After illustrating the chapters entitled "Geology, the Science of the Earth" and "The Method and Scope of Geologic Study," the series continues with pictorial representations of weathering, erosion, running and subsurface water, glaciers and glaciation, sedimentary and igneous rocks, volcanoes, earthquakes, metamorphism, the origin and history of mountains, land forms and mineral resources. The complete set includes general scenes, many of which are aerial photographs, as well as close-ups of typical formations and specimens.

Colorful to excite interest and grainless to allow for great screen expansion, the slides aim at providing a clearer understanding of the elements of a particular problem and furnishing easier visualization of theoretical concepts, as well as at making learning more lasting. They are made of unbreakable film and are sturdily bound into the new plastic mounts. The 250 slides come in a convenient package, weighing about three pounds, and are accompanied by a useful instructor's manual offering suggestions for using them correctly. Complete captions are printed in the manual, keyed both to the slides in the package and to the text of the book. The price of the entire set is $85.00.

Another offering of the Wiley visual aids department will be a comprehensive set of slides, also to be prepared by Dr. Childs, to supplement the forthcoming fifth edition of HISTORICAL GEOLOGY, by Carl O. Dunbar and the late Schuchert, to be published early next year.

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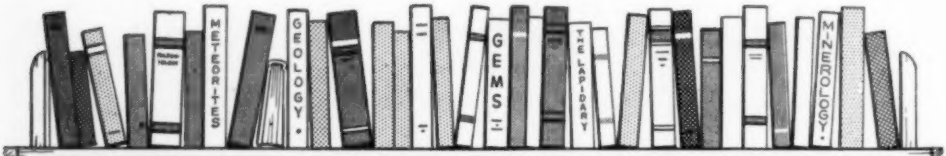

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